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ABSTRACT

This report summarizes one of a series of workshops organized by RAND's Critical Technologies Institute (CTI), on behalf of the U.S. Department of Education, to take advantage of the experience and insights of those already implementing new technologies in schools. The workshop consisted chiefly of dialogues with educators and experts from the private sector who are working to apply emerging telecommunications systems for learning. The summary serves in part as an overview of recent progress in the area of school connectivity; it gives specific examples of how schools have secured funding, built relationships with telecommunications providers, acquired necessary equipment, and nurtured the philosophy of making technology use part of larger instructional goals. The second part highlights the dilemma of purchasing stand-alone or networked computers, while part three is a discussion of cost issues. Conclusions drawn from the dialogue suggest that the transition to technology-rich schools has begun in earnest, often without federal aid or guidance. The government must remain neutral in the aspects of technology acquisition which pertain to private enterprise, but it could encourage schools around the country to plan for technology. Educators, for their part, should foster a driving vision for technology in their school communities. An appendix lists the participants. (BEW)

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RAND

Planning and Financing Education Technology

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PREFACE

Urged on by both the President and Vice President, federal officials have been exploring how to encourage greater and more effective use of modern telecommunications and computer technologies in the nation's schools. In July 1994, RAND's Critical Technologies Institute (CTI) completed a broad investigation of educational technology for the Office of Science and Technology Policy and the National Science and Technology Council. This preliminary work examined the nature and level of federal efforts to assist educators and trainers and an assessment of major barriers to further progress.

On the basis of this preliminary investigation, the U.S. Department of Education asked CTI to assist the department as it responded to new provisions in the Improve America's Schools Act, 1994, calling on the Secretary of Education to provide a plan, by September 1995, for effective utilization of new technologies in the nation's classrooms.

This report summarizes the second of four workshops organized to take advantage of the experience and insights of those already implementing new technologies in the schools. The first workshop examined professional development needs. This workshop on planning and financing technology, like the earlier one, consisted of a one and one-half-day conversation with educators and experts from the private sector working to apply emerging telecommunications systems for learning. Appendix A lists the participants. Between January and March, two additional workshops--one on equity, the other on software--are also planned.

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PLANNING AND FINANCING EDUCATION TECHNOLOGY

LANS ... SPARC stations ... Internet servers ... 56 Kbps service ... WANS ... T-1 lines ... CD-ROMs ... UTP cable ... NII ...--for the newcomer, the complexity of technologies available to schools quickly becomes bewildering, made all the more confusing by the pervasive jargon of technology's initiates and advocates. Adding to the confusion is the startling range of cost estimates produced by various experts--from about $35 per student, per year, according to some--to $200, or more, according to others. How is one to make sense of all of this?

State and local governments have properly been called the laboratories of democracy--places in which new ideas can be developed and tested, and new ways of conducting the public's business explored. In order to get a better fix on the complexity and costs of planning and financing education technology, RAND invited several state and local education leaders as well as representatives of the business community to a workshop to discuss their experiences with education and technology and what they have learned.

At this workshop, several things became quickly apparent. First, the education technology train has already left the station. State and local education agencies at the cutting edge have already made significant progress. Indeed, as the participants made clear, most schools have gone about as far as they can go in terms of purchasing emerging technologies from the discretionary part of the school budget.

Second, the term "technology" covers a lot of ground--from equipment as tradition as overhead projectors and public address systems to more advanced multimedia workstations and connections through the National Information Infrastructure (NII) to Internet and the information highway.

Third, what it costs depends upon what is bought. Cost estimates inevitably change as planners include (or ignore) various elements. is the estimate for a networked or a stand-alone system? do the estimates include costs for school wiring (both communications and power)? Or do

they not? What about hardware? Software? Staff development? On-going support?

SIGNIFICANT PROGRESS

The first thing to be said is that even though district and state education leaders have little guidance--they may not always know what they want, they are not always sure what they need--many are plunging ahead with technology implementation, learning as they go.

The Speaker of Nebraska's unicameral legislature, Ron Withem, got excited about the possibilities of telecommunications in a sparsely populated rural state, and wanted every teacher on Internet, according to Wayne Fisher of the Nebraska Department of Education. Legislation was signed in March 1993 and, precisely 12 months later, the state had a system in place that put Internet within the reach of every teacher--even if every teacher and school did not take advantage of it.

Nebraska accomplished this by (1) working with the association representing 42 different telephone companies; (2) insisting that the telephone companies offer a "comprehensive deal"--a reduced price in return for delivering access to all students and a school market; and (3) having each Education Service Unit (ESU) in the state pay for leasing a 56 Kbps line to the unit. Since every school in the state is within 100 miles of an ESU, schools and teachers interested in participating could readily draw on the service from the ESU if they wished to. About 200 schools out of 1,100 in the state are now on line.

In New York State there is hardly a school building that does not have at least some technology, according to Mike Radlick of the New York State Department of Education: 99 percent have at least one micro-computer; more than half have a CD-ROM drive (compact disks capable of holding hundreds of thousands of pages of text, hours of speech or music, several hundred high-resolution color photographs, or any combination of these); three-quarters have access to cable television and nearly one-half have a LAN (a local area network--for example, half a dozen computers connected to the same printer, or three computers which can share the same data base).

In fact, New York's 717 school districts spent more than $360 million on technology in 1993, for an average expenditure slightly about $501,000 per district.

Our society needs to find some way to apply the corporate model of investment in technology to the public sector, suggested former Iowa state senator Richard Varn, now director of telecommunications at the University of Northern Iowa. Corporations act on the assumption that investments in technology can help reduce personnel costs by as much as 50 percent, while increasing productivity by up to 1,000 percent.

In Iowa, he said, more than 3,000 miles of fibre-optic cable have been laid in all 300 counties. It serves national guard units, prisons, hospitals, state agencies, and public and private schools. Three things are critical to state-wide educational technology efforts according to Varn: the network itself, competent people, and computers in the schools. Success rests on those three legs of the stool: "Start with any one of the legs. It does not matter which one. Make progress in one area and everything else will move along with it. Create the network--schools will invest in computers. Train people--they will demand the network and the computers. Put computers in the schools--educators will insist on the need for training and for connecting with each other."

Nebraska's Wayne Fisher offered similar advice--state and local leaders should just push ahead, even if they are not really sure at the outset how it will work out. Nobody really knows where they are going with all of this, according to Fisher, "We did not have a book on how to proceed--and we did not need one. We found that all we needed was to roll up our sleeves to make it happen--then, it just all fell into place."

A similar kind of activists' enthusiasm for just getting on with the job was brought to the workshop by representatives of two school districts--Perry Public Schools, Perry, Ohio, and Central Kitsap in Silverdale, Washington, each with well-developed technology programs and plans. (By contrast, New York State plans are not fully operational across all districts.)

By one measure, the Perry district is a low-income district, with a median family income of about $26,500 per year, nearly one-third below the national average. But single measures can be deceptive. Thanks to the revenue thrown off by a nuclear power plant in the district, Perry residents are able to spend a small fortune on their schools--average per-pupil expenditures of $11,244, compared to a state average of approximately $5,100.

District officials, according to superintendent Scott Howard, are committed to the concept of a "community education village," with access to local, national, and global information universally available from the home and school. Technology is seen as a tool to enhance instruction, improve administration and school support, and foster communication within the district and between schools and the home.

In pursuit of these goals, Perry has spent more than $5.8 million simply on equipment and cabling to create a local area network made up of 306 classroom and office workstations (personal computers), 186 workstations in ten laboratories; and 75 notebooks and stand-alone computers for teachers.

Central Kitsap officials are also ambitious for their community and their schools. "How do we create a 'culture of learning' within the district?" asked Ron Gillespie assistant to the superintendent. "What does that mean? How do we do it?" Technology, according to Gillespie, may supply the answer.

According to Gillespie, technology can succeed only if embedded in larger educational goals--e.g., the need for adult advocates, improving teacher professionalism, encouraging collaboration between the home and the school. "Like everything else we do in schools, the effective use of technology should focus on learning. The problem is that most people in technology become entranced with the hardware--they forget why it is there. So we have to balance the technology people (interested in the technical aspects of the hardware) with the educators (interested in projecting learning beyond the four walls of the schools), with the interests of parents and the community--many of whom are uninterested in all of this technology talk. They just want to go back to basics. We found it was important to bring the community along."

Gillespie descried a two-part effort. The first was designed to network the staff--teachers, administrators, clerical, and janitorial staff. The second networked the students. Both stages took place in one school. "We had a great equity debate in the district. Do we pour money into on school to demonstrate that this will work? Or do we 'dribble' money out all over the district. We picked the first option--and after demonstrating it worked, we got a bond issue passed."

STAND-ALONE VERSUS NETWORKED SYSTEMS--WHERE IS TECHNOLOGY GOING?

An interesting aspect of this workshop was that participants were quite content to talk about quite different kinds of equipment and capabilities--all under the general rubric of technology--despite the fact that everyone at the workshop understood they were talking about quite different things.

A major distinction lay between self-contained educational systems (within schools and school districts) and networked systems that extended the school's reach into the wider world via the Internet. For example, digital computer technology coexisted easily with analog video systems for distance learning.

The Nebraska program is a statewide network providing access to Internet through the state's system of ESUs. In fact, unless districts and schools go to the trouble of wiring themselves into the ESU, neither teachers or schools have access to Internet.

Ohio's Perry Public Schools, by contrast, have mounted a technology effort that is internal to the school district, which emphasizes computer and video hardware expenses about equally.

In fact, workshop participants thought there might be a lot to recommend in all this variability. Don Gibbs of the Federal Communications Commission noted that the FCC is extremely interested in bringing the benefits of telecommunications to the classroom. But, he said, in this area, like others, FCC's first principle is, "We want to be competitively and technologically neutral. Competition between cable and telephone companies is a bit messy right now. We do not want to be in the business of figuring out the right technological solution."

"Where," asked association head Rick Weingarten, "is technology going? Should the country put $50-$100 billion into ground lines of one kind or another, only to find that the while thing is out of date in five years? 'Techies' are now talking about 'ubiquitous computing'--people wandering around with small computers in their cars, even their pockets and pocketbooks, all hooked up by wireless, at all times, wherever they are."

What we should be moving forward on is the effort to make sure that education technology systems are "open" suggested Lee McKnight of MIT. The business world moved forward with its investments in technology on faith, said McKnight, it really had no positive evidence that investing in computers would improve productivity.

Schools should do the same thing, without really expecting "robust data" on education improvements for some time. Nonetheless, warned McKnight, policymakers do need to face the interoperability problem. Left to their own devices, private providers will simply get in each other's way in an effort to lock up markets. "Our mantra should revolve around openness, extensibility, and scaleability. We should aim for open systems in which different technologies can operate with each other--interoperability. We should also worry about extensibility--even if we are not sure what lies down the road five years from now, we should be able to extend our current systems easily. Finally, whatever is put in place should have the benefit of scaleability--schools and districts should be able to sale up their systems--plan ahead to accommodate data, voice, and video transmissions, for example."

COST ELEMENTS

Finally, to the heart of the matter, what does all of this cost? Inevitably, what it costs depends upon what is purchased. But some guiding principles stand out.

The cost of Internet service itself to the school door is modest and a modest fraction of the total technology cost, so long as demand for many schools or school districts is aggregated before linking to an Internet service provider. Bringing the service to each classroom or to each student's desk is another matter altogether.

Increasing the number of classroom computers from one to four or five, adding one or two servers for local use and for Internet mail, adding a dial-in model pool for student and parent use at home, and some printers and scanners, black and white or color, raises the ante very considerably, even without including the cost of analog video service for distance learning. For the examples considered, the added video capability increased equipment cost by 20 to 30 percent.

The cost of school-site wiring for power, which was deemed a matter in need of critical review and upgrading, and to link school computers in a local area network, will add another increment of cost, which can be substantial depending upon the safety and security measures thought necessary. AT&T's Al Zeisler provided the most comprehensive and detailed cost mapping for a "Structured Cabling System" for schools capable of carrying simultaneous voice, data and video transmissions. Depending upon the number of voice and data jacks installed in each classroom, the library, and administrative areas, Zeisler estimated that the total national cost of cabling every K-12 public school would range from a low of $1.6 billion to a high approaching $6.0 billion. The wide variance results from the difference in installing a minimum cabling system, to one that would permit the operation of a full breadth of technology-based equipment.

Finally, there are additional operating costs for technical assistance, either school staff or in the form of a maintenance and service contract, for teacher training in the educational applications of all the technologies, and for materials and supplies.

On an annualized cost basis, the cost of equipment, wiring, services and supplies can increase the per student cost of technology from the current national average of between 3/4 and 1 percent to between 3 and 5 percent of total educational expenditures, or from $45 to $60 per student to between $135 and $300 per student.

A cost model developed for the Department of Education by Russell Rothstein approached the Zeisler estimates. As Mr. Rothstein put it, "A school with a single PC and model may access certain NII services. However, the costs for this school are considerably less than the costs for a school with multiple networked PCs in every classroom and a high-

speed connection to the NII. In the former model, the costs per student are less than $10 in one-time costs and less than $15 in annual on-going costs. In the latter model, costs per student exceed $250 in one-time costs, and exceed $42 in annual on-going costs. The costs to install this standard of technology in every school in the nation are from $12-$28 billion in one-time costs and from $2-$5 billion in annual costs."

Another way to look at these figures, of course, is to compare them with expenditures already being made in the schools. The Zeisler model places the total national cost of technology and its support components to be incurred at the school and district level at approximately $85 billion over 16 years, assuming that all students/teachers at all schools are provided with a relatively complete and assessable technology base of equipment. As participants pointed out, an average of $200 per student amounts to 3 percent of what is now being spent per pupil on education in the United States, or as Zeisler put it, it represents about $1 per day, per student.

IMPLICATIONS

From this workshop, several conclusions stand out.

First, schools, districts, and states appear to be doing a great deal, with or without federal assistance and guidance. Like corporations investing in technology simply out of the conviction that it was the right thing to do, schools are also investing in new technologies, largely on faith.

Second, educators do not appear to have a single, compelling vision driving them toward technology. Some argue for changing the culture of the schools. No one at this workshop argued that technology is essential to reach emerging educational standards or new national education goals. Schools appear to be moving to the beat of an external drummer--technology is now ubiquitous in American life and students need to be exposed to it.

Largely as a result of the lack of a single vision, different schools, districts, and states are emphasizing different things--stand-alone systems, networking, asynchronous data communication and synchronous video. Whatever these schools are emphasizing, it is clear

that in some lighthouse schools and districts, the transition to technology-rich schools is already underway.

The federal role in all of this is quite complicated and difficult. If the federal government acts effectively, it can help assure a smoother, faster, and more equitable transition. However, as the FCC participants pointed out, the federal government needs to be competitively neutral in an area that is dominated by private, profit-making entities. Not only must it be competitively neutral, it must be technologically neutral--technologies have developed and changed so rapidly just in the past five or ten years that it would be silly for the federal government to pretend it understands how technology will develop in the next decade.

In this light, encouraging schools to plan sensibly and carefully might be something the federal government can usefully do. As McKnight suggested, public officials should be encouraging technology that is open, interoperable, and can be extended to meet the demands of the future.

At the same time, there can be little doubt that financing the substantial expenditures required if schools are to enter the information age in any serious way is a serious problem. The federal role in financing should not be to pay for the transformation, but to help districts and states think through and recognize and consider new options as to how they themselves can afford to proceed.

In fact, a number of workshop participants made the point that the cost issue is not a serious problem at all for new school buildings. These buildings can easily be wired as they are put up. For existing schools, it appears that expenditures will have to rise from about 1 percent (or less) of per pupil spending on technology to an average of about 2 to 4 percent. This increase, while in many ways apparently modest, cannot be financed out of residual school budgets--i.e., what is left after all of the really important expenses have been taken into account, or until all of the traditional claimants on the school budget have made their claim. For increases of this magnitude, some top-down financing and planning is required. Schools must also actively seek out money that may be able to be shifted to technology investment as a

result of the increased use of technology and the costs it may save (e.g., video instead of long distance busing; CD-ROMS instead of increased library size; library pooling via networks).

The truth is that for less than $1 per school day, American students can have access to, and benefit from, state-of-the-art educational technology. It is a bargain at twice the price. Nonetheless the up-front capital costs of wiring building and purchasing hardware are formidable--and most public entities do not understand how to deal with them creatively.

Wiring and remodeling buildings and purchasing telecommunications equipment represent genuine capital expenditures. Schools should not be expected to pay for them all at once out of operating budgets.

Over the last 100 years, school budgets have increased by a little over 3 percent annually (in real dollars), and grown sufficiently to include new costs like school lunch, school busses and bilingual education. Over the long run, appropriated budgets might increase sufficiently on this pattern to include the costs of computer hardware and software technology.

However, schools and school districts wishing to advance quickly have to overcome the problem of meeting a substantial front-end capital cost. The traditional instrument of choice, the 30-year bond issue, doesn't match the four to five year life expectancy of computer technology very well. Leasing, for example, may be an appropriate option to be adopted by the education community.

The federal government might consider working with state and local education agencies in order to find new ways of quickly and equitably bringing the nation's schools into the computer technology and information age.

Appendix

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